Researchers find massive impacts dispersed chlorine, helped make Earth habitable

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Credit: NASA

(Phys.org) —Life as we know it may not have existed if the Earth wasn't repeatedly bombarded by massive planetary bodies more than 4 billion years ago according to new research conducted by scientists at the University of New Mexico and NASA Johnson Space Center. The results of the massive collisions indicate that much of Earth's supply of chlorine was blown away creating a habitable environment suitable for the existence of complex forms of life – including humans.

In a paper titled, "The chlorine abundance of Earth: Implications for a

habitable planet," published recently in an issue of *Earth and Planetary Science Letters*, UNM Regents' Professor Zach Sharp, UNM Department of Earth and Planetary Sciences, and David Draper of the NASA Johnson Space Center in Houston, Texas (formerly of UNM's Institute of Meteoritics), research suggests the removal of the chlorine through these collisions helped provide Earth the means necessary for its own evolution.

Based on the composition of age-old meteorites, Earth should have 10 times more chlorine than what researchers see. The possible explanations for the missing chlorine included unrecognized sequestration in the core, a higher nebular volatility than normally presumed or a preferential loss of heavy halogens during planetary accretion. On Earth, heavy halogens including chlorine and bromine are depleted by an order of magnitude more than would be predicted on the basis of their volatility.

Draper and Sharp ruled out the possibility of the chlorine hiding out in the core after simulating the conditions of the core with partitioning experiments between molten metal and silicate to estimate the contribution from the core and evaluate different hypotheses for the depletion of Earth's halogens.

"We conducted high pressure experiments and mimicked the exchange," Sharp said. "We had high temps and pressures 80,000 times higher than Earth's atmospheric pressure, added extra chlorine, and all of it went into the silicate. We saw that there was a chlorine deficit of a factor of 10. So we thought 'what's going on?' We had our data and our results, but now we have to figure out what's happening here."

The researchers then came to the conclusion that huge, planetary bodies slamming into the Earth more than 4 billion years ago blew away the chlorine at the surface, and thus, making Earth much more habitable for complex living organisms. Conversely, Mars, which has twice as much

chlorine as Earth does, suffered fewer larger impacts due to its smaller size.

Sharp also said there was a paper that suggested that just before Cambrian explosion for life, salinity of oceans were higher by a factor of two. About half of chlorine is in the crust and the rest is in the ocean and in massive salt deposits, like in Carlsbad, N.M.

Almost half of chlorine and bromine is in the ocean. A similar concentration should be seen for iodine, but it is sequestered by marine algae, keeping concentrations low.

"It's unique because they (chlorine and bromine) do not go into any minerals or metals. Instead, they are concentrated in the oceans at levels far beyond those for any other element," Sharp said.

"With these high impact collisions some of the material at the surface was lost," Sharp added. "Had the high impact collisions not occurred, the chlorine content would be so high; about 10 times as much as we have now. With 30 percent salinity, it would be the same as the Dead Sea. It would really be a nasty environment. Sure, it is possible organisms might have adapted to that type of environment, but we would have never had life like we do now. If we did, it probably would have been limited."

With such a high salinity over water, there would be a much lower concentration of oxygen and there wouldn't have been as much precipitation or rainfall, and runoff and nutrient return to the oceans would be low. It would not be a very favorable planet for life. With the massive removal of salt from ocean, salinity is far lower and the solubility of oxygen is far higher than it otherwise would be. As a result, organisms were able to evolve into more larger, complex forms of life.

"Had the massive collisions not occurred, it would not be unreasonable

to say there would not be life on Earth," Sharp said. "The necessary conditions to have life on Earth were not present. It sounds profound but in any kind of solar system equivalent, these collisions are one of those fortuitous things that must occur to make the planet habitable for life."

Provided by University of New Mexico